

**REMARKS**

Claims 1-19 are pending. Claims 1 and 19 are amended. Claims 15-18 are withdrawn from consideration.

Claim Amendments

Claims 1 and 19 have been amended to specifically recite the sequence in which the steps of the method are conducted. No new matter has been added to the claims.

Claim Rejections – 35 U.S.C. §103

Claims 1-14 and 19 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Waldron et al. (US 6,168,067) in view of Sainfort et al. (US 5,560,789). Applicant respectfully requests reconsideration and withdrawal of the rejection.

Claims 1 and 19 have been amended to recite the following process steps in the sequence provided:

- 1) homogenization heat treatment;
- 2) friction stir welding; and
- 3) solution heat treatment.

The claimed invention is directed to a process designed to weld by friction stir welding members which are made of heat treatable alloys. It is well known to one skilled in the art that heat treatable alloys respond to thermal treatments based on phase solubilities and can be hardened by a controlled cycle of heating and cooling. These treatments include solution heat treatment, quenching, and precipitation, or age, hardening. Solution heat treatment is a process which consists of soaking the alloy at a temperature sufficiently high (generally above 400 °C) and for a time long enough to achieve a nearly homogeneous solid solution. Quenching is a process designed to preserve the solid solution formed at the solution heat treating temperature, by rapidly cooling to some lower temperature, usually near room temperature. After solution heat treatment and quenching, hardening is achieved either at room temperature (natural

aging) or with a precipitation heat treatment (artificial aging, which is a low temperature, generally from 115 to 190 °C, long term process).

In order to obtain a high mechanical strength at all points, including in the zone affected by welding, solution heat treatment is conducted after friction stir welding. However, during solution heat treatment, grain size in the heat affected zone of the weld may increase dramatically, because the energy stored in the grain boundaries in the zone affected by friction stir welding operation is high. This phenomenon is explained in [0012], [0013] and [0014] of the present application.

The inventors in the present application found that, unexpectedly, the problem of uncontrolled grain growth during solution heat treatment can be solved by subjecting the elements to be welded to a homogenization heat treatment before friction stir welding, at a temperature T for at least  $2t_1$ , wherein  $t_1$  comprises a minimum treatment duration at temperature T leading to a specific melting peak energy defined by Differential Scanning Calorimetry of less than 1 J/g, and wherein the treatment duration is at least 72 hours. This result is unexpected because a homogenization heat treatment before friction stir welding, as claimed in amended claims 1 and 19, would not be expected to affect grain size of the welded joint during solution heat treatment of the welded assembly. The Ehrstrom Declaration dated October 29, 2007 provides the reason the present inventors believe that this unexpected result occurs. . In particular, Ehrstrom stated that

“In a process of the present application, the duration of homogenizing and/or intermediate heating and/or treatment of a partly finished product is significantly increased in order to not only obtain phase dissolution, but also to obtain coalescence of dispersoids which were found to enable the formation of fine grains after solution heat treatment of the friction stir welding part.”

(Ehrstrom Declaration, page 3). This statement means that the heat treatment is not used for its known effect on phase dissolution but for an effect on dispersoid coalescence, which unexpectedly affects grain size in the zone affected by welding during solution heat treatment.

As stated in the amendment dated October 12, 2006, the Waldron et al. disclosure is not directed to a process wherein solution heat treatment is carried out on the welded assembly. Waldron et al. teach:

- 1) solution heat treating a structural member
- 2) quenching
- 3) friction stir welding; and
- 4) aging

(Waldron et al., column 2 lines 1 to 14). While Waldron et al. teach a cooling of the weld called "quenching" during the moving step (i.e., during friction stir welding), this type of operation does not constitute a solution heat treatment and quenching of the structural assembly after friction stir welding, as instantly claimed. (Waldron et al., col. 2, lines 25-26). Waldron et al. do not teach a solution heat treatment after welding but rather, disclose a precipitation hardening known as natural or artificial aging (see column 2 line 13-14 and column 6 lines 12-16).

In the claimed invention, by conducting a process in which the solution heat treatment is conducted after friction stir welding, very large grains are formed in the welded zones during solution heat treatment (see [0013] of the pending application). This is contrary to the situation taught by Waldron et al., where the solution heat treatment is conducted before friction stir welding. The process taught by Waldron et al. is a different process which does not encounter the same problem as the claimed process, and therefore cannot solve the same problem that the claimed process solves.

Furthermore, Applicants respectfully disagree with the Examiner's assertion that the Waldron et al. disclosure covers the claimed welding steps.

It is further noted that, as acknowledged in the Amendment filed on Oct 12 2006, the Litwinski reference is more relevant than the Waldron et al. reference. Litwinski teaches a solution heat treatment of a welded assembly. However, there is no teaching in Litwinski to subject the elements to a heat treatment twice as long as the typical duration

of solution heat treatment. The difference with the Litwinski reference was specifically addressed in the Ehrstrom Declaration dated October 29, 2007.

“However, Litwinski does not teach a heat treatment (homogenizing and/or intermediate heating and/or treatment of partly finished product) before friction stir welding with a duration significantly longer than the normal homogenization or solution heat treatment duration for the same alloy. To the contrary, in Figure 4B in column 7 lines 35 to 40, Litwinski teaches normal solution heat treatment duration. Indeed,  $t_1$  from Figure 4B is defined by Litwinski as a “a sufficient period of time to allow the  $\alpha$  phase to dissolve”. As explained above, it corresponds to normal solution heat treatment duration. Litwinski teaches another method to control grain size after friction stir welding and solution heat treating the welded part : to heat the friction stir weld tool prior to and during the forming step of the weld joint (column 4 lines 10 to 13).”

(Ehrstrom Declaration , paragraph 4).

Applicants respectfully disagree with the Examiner’s assertion that what is deficient in Waldron et al. (or Litwinski) is a process step drawn to enhancing good mechanical behavior of the alloy and that such a step is taught by Sainfort .(page 5 line 16 of the outstanding rejection).

As stated in the amendment dated February 13, 2008 the Sainfort et al. reference does not provide any disclosure of friction stir welding or welding of any type. The Sainfort et al. disclosure is directed to improving strength of the alloy itself, whereas the claimed invention is directed to improving the strength of the welded joint by avoiding an uncontrolled coarse grain structure. One of ordinary skill in the art attempting to solve the problem of avoiding the formation a coarse grain structure in the zone affected by welding during solution heat treatment would not have turned to the Sainfort et al. reference for direction, since this reference is directed to a different problem.

Moreover, Sainfort et al. do not teach that a treatment duration of more than 48 hours would provide any benefit at all. Applicants respectfully submit that the Examiner’s disagreement regarding this assertion on the basis of column 2, lines 5-25 of Sainfort et al. is incorrect. In column 2, lines 5-25, Sainfort et al. provide mechanical properties that can be reached by a particular alloy, and do not provide any treatment

duration , and in particular do not teach a treatment duration of more than 48 hours. This issue is explained in detail on pages 6 and 7 of the Amendment dated February 13, 2008.

Finally, even if one skilled in the art had, independently of the above mentioned problem of avoiding a coarse grain structure in the zone affected by welding, decided to apply the Sainfort et al. disclosure in order to improve the mechanical behavior of the alloy outside the zone affected by welding, he would not have arrived at the claimed invention. By applying the Sainfort et al. teaching, one skilled in the art would not have subjected the elements to heat treatment at a temperature  $T$  for at least  $2t_1$ , wherein  $t_1$  comprises a minimum treatment duration at temperature  $T$  leading to a specific melting peak energy defined by Differential Scanning Calorimetry of less than 1 J/g, and wherein the treatment duration is at least 72 hours. To the contrary, one would have subjected the elements to heat treatment at a temperature  $T$  for  $t_1$ , wherein  $t_1$  comprises a minimum treatment duration at temperature  $T$  leading to a specific melting peak energy defined by Differential Scanning Calorimetry of less than 1 J/g, because this is specifically the teaching of Sainfort et al. (Sainfort et al., col., 2 line 3). The treatment duration would most likely have been less than 72 hours because Sainfort et al. do not provide any motivation to make a treatment of more than 48 hours.

For at least the above reasons, claims 1 and 19 are allowable over the asserted combination of Waldron et al. and Sainfort et al. Claims 2-14 are allowable at least because they depend from claim 1, and are believed to further patentably distinguish.

**CONCLUSION**

In view of the above amendment and foregoing remarks, Applicants believe the pending application is in condition for allowance.

If a fee is due, please charge our Deposit Account No. 09-0528, from which the undersigned is authorized to draw.

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Respectfully submitted,

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